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ABSTRACT

This instructor's guide, designed for use with the curriculum, Plant Operations for Wastewater Facilities, represents a two-year wastewater technology instructional program based on performance objectives designed to prepare undergraduate students to enter occupations in water and wastewater treatment plant operations and maintenance. This document, part E of five parts, covers the topics of Flow Measurement, Pumping and Piping, Electric Power and Gas Power. In this guide, the topics and ideas are presented as a series of modules, organized around 16 general objectives common to all processes. The module begins with a statement of purpose which explains what the student will be studying. Next, all the objectives of the module and code numbers keyed to a computerized list of instructional resources are listed. Also included in each module are a glossary of verbs and sections on learning and testing conditions, acceptable performance, instructor activity and student activity. Recommendations on evaluation techniques are included. (BT)

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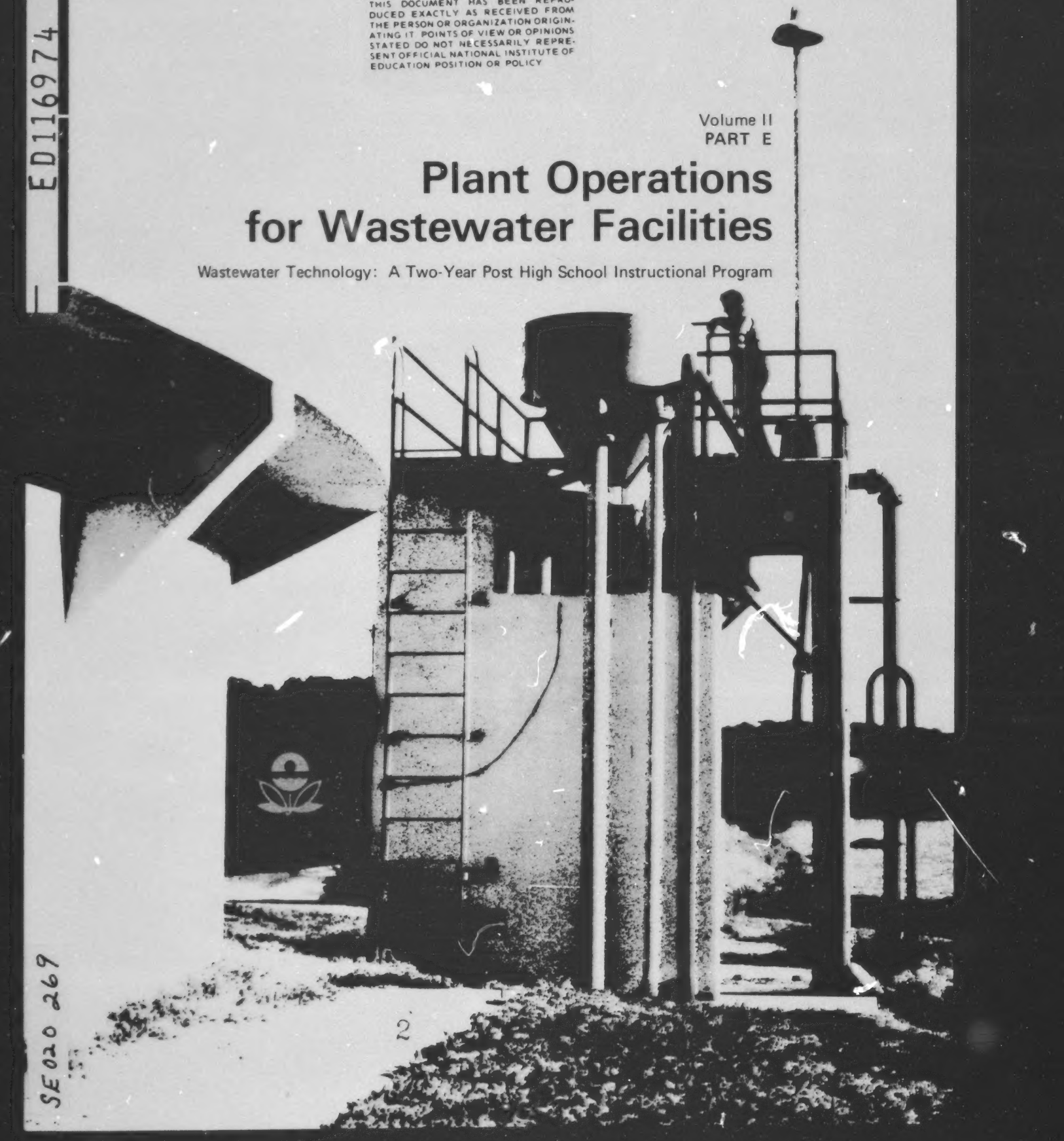
Volume II
PART E

Plant Operations for Wastewater Facilities

Wastewater Technology: A Two-Year Post High School Instructional Program



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PLANT OPERATIONS FOR WASTEWATER FACILITIES, Part E

Flow Measurement
Pumping and Piping
Electric Power
Gas Power

An Instructor's Guide for Use of Instructional Material
In Wastewater Technology Training Programs

Funded by

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Preface

Since 1970 Charles County Community College, Clemson University, Greenville Technical College and Linn-Benton Community College have been working together to prepare undergraduate students to enter occupations in water and wastewater treatment plant operations and maintenance. Through their efforts a two-year wastewater technology instructional program based on performance objectives has been developed and implemented.

Through a grant from the Environmental Protection Agency called *Criteria for the Establishment of Two-Year Post High School Wastewater Technology Programs (CEWT)* the four colleges set up program criteria and curriculum guidelines which are available in two volumes:

Program Implementation Procedures
Volume II: Curriculum Guidelines, Criteria for Establishment and Maintenance of Two-Year Post High School Wastewater Technology Programs

As a result of the implementation of the instructional program at Charles County Community College, Greenville Technical College and Linn-Benton Community College, six guides for instructors based on the course descriptions in *Plant Implementation Procedures* and the general criterion behaviors of *Volume II* have been prepared. *Plant Operations for Wastewater Facilities*, printed in five parts, is the second in the series which includes:

Volume I *Introduction to Environmental Technology*
Volume II *Plant Operations for Wastewater Facilities*
Volume III *Laboratory Control for Wastewater Facilities*
Volume IV *Management and Supervision Procedures for Wastewater Facilities*
Volume V *Process Interaction for Wastewater Facilities*
Volume VI *Advanced Waste Treatment*

ACKNOWLEDGEMENTS

Since the beginning of the project many persons at the four cooperating institutions, as well as outside consultants have participated in the development of this program. Their efforts which have provided source material for this guide have been acknowledged in the volumes to which they made major contributions. *Plant Operations for Wastewater Facilities* has been written and produced by:

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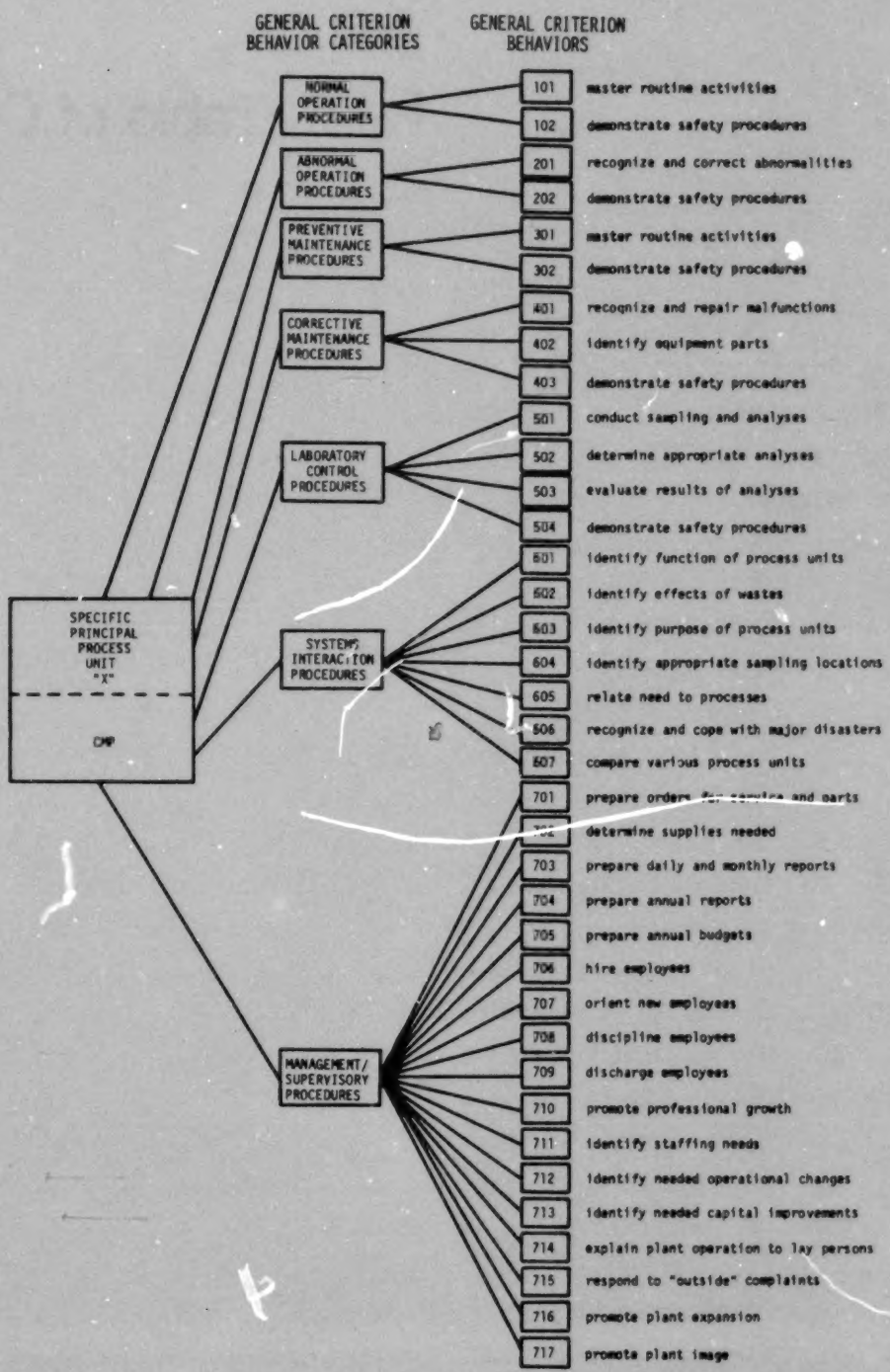
GENERAL CRITERION BEHAVIOR CATEGORIES
GENERAL CRITERION BEHAVIORS
SPECIFIC PRINCIPAL PROCESS UNIT "X"
CMP
NORMAL OPERATION PROCEDURES
ABNORMAL OPERATION PROCEDURES
PREVENTIVE MAINTENANCE PROCEDURES
CORRECTIVE MAINTENANCE PROCEDURES
LABORATORY CONTROL PROCEDURES
SYSTEMS INTERACTION PROCEDURES
MANAGEMENT/ SUPERVISORY PROCEDURES
101 master routine activities
102 demonstrate safety procedures
201 recognize and correct abnormalities
202 demonstrate safety procedures
301 master routine activities
302 demonstrate safety procedures
401 recognize and repair malfunctions
402 identify equipment parts
403 demonstrate safety procedures
501 conduct sampling and analyses
502 determine appropriate analyses
503 evaluate results of analyses
504 demonstrate safety procedures
601 identify function of process units
602 identify effects of wastes
603 identify purpose of process units
604 identify appropriate sampling locations
605 relate need to processes
606 recognize and cope with major disasters
607 compare various process units
701 prepare orders for service and parts
determine supplies needed
703 prepare daily and monthly reports
704 prepare annual reports
705 prepare annual budgets
706 hire employees
707 orient new employees
708 discipline employees
709 discharge employees
710 promote professional growth
711 identify staffing needs
712 identify needed operational changes
713 identify needed capital improvements
714 explain plant operation to lay persons
715 respond to "outside" complaints
716 promote plant expansion
717 promote plant image

Figure 1: Relationship of general criterion behaviors (performance objectives) to the general categories and composite model plant (CMP).

Performance Objectives

When the treatment plant operators, educators, consultants and representatives from professional water pollution control organizations came together to develop an effective instructional program, they recommended the use of performance or behavioral objectives because such objectives clearly outline:

1. What the student is expected to do as a result of the instructional program.
2. The conditions under which the student shall do it.
3. The standard of performance.

COMPOSITE MODEL PLANT

First, they developed a composite model plant (CMP) of twenty-two process units which is really many wastewater treatment plants in one model. Such a mix of process units seldom occurs in a treatment plant, but if a student becomes competent in the operation and management of the CMP he should be able to perform successfully in any treatment plant.

TASK ANALYSIS

Next, to ensure that the materials were specifically tailored to what the operator does on the job, a task analysis was conducted. They found that the tasks which an operator performs fell into seven general categories which were further divided into 37 tasks or general behaviors. (See figure 1, page vi.) The tasks were organized under:

1. Normal Operation Procedures. These include routine operating activities that do not vary significantly from day to day and that are designed to keep the plant functioning within a normal range of values. For example, the employee conducts routine samplings of the primary sludge and inspects pumping equipment and the wastestream to verify that the process is functioning properly.

2. Abnormal Operation Procedures. These include activities of the plant employee that result from unusual and undesirable conditions of the wastestream. The abnormal procedures enable the plant employee to recognize when the wastestream is abnormal and to return it to an acceptable, normal condition. An abnormal wastestream results when a normal operation procedure is not properly applied, a corrective maintenance procedure is needed or management/supervisory procedures are poor. For example, the plant employee should recognize that a black septic primary sludge sample is an abnormal condition of the wastestream and take appropriate action.

3. Preventive Maintenance Procedures. These include routine maintenance activities of the plant employee which prevent major equipment breakdown and subsequent corrective maintenance. For example, the employee would lubricate bearings and other moving parts, replace worn components and adjust components of the primary sludge pumps.

4. Corrective Maintenance Procedures. These include maintenance activities of the plant employee that usually result from the breakdown or malfunction of a unit of equipment or a component. For example, the employee would notice whether the primary sludge pump is malfunctioning and know when and how to correct the disorder or when and how to refer the problem to plant maintenance personnel.

5. Laboratory Control Procedures. These include special and routine activities relating to laboratory analysis, the specification of sampling procedures and locations and the general management of the laboratory facilities. For example, the employee would collect primary sludge samples and conduct the analyses.

6. Systems Interaction Procedures. These include activities of the plant employee which relate the functioning of specific units of equipment to other process units and to the system as a whole. For example, the employee would determine how the effective functioning of the primary sludge pumps relates to digester performance.

7. Management/Supervisory Procedures. These include activities relating to employment practices, record keeping, plant operation policy and the establishment of a constructive and realistic rapport between the plant and the community it serves. For example, the employee would keep records on primary sludge pumping, keep an inventory of spare parts and evaluate the adequacy of maintenance procedures by shift personnel.

CURRICULUM DESIGN

After deciding what process equipment an operator must operate and maintain, and finding out what an operator does through the task analysis, they listed the objectives a student must master to successfully operate a treatment plant. For example, the student will describe and perform the normal inspection procedure for the primary sedimentation unit including frequency of inspection, conditions to look for and the actions he should take.

INSTRUCTOR'S GUIDES

The next step was the design of manuals to guide the instructor. In the guides varied learning activities and imaginative innovations which produce more learning than traditional teaching methods are emphasized. The instructional suggestions do not need to be followed slavishly, but should be modified and improved as much as possible.

The instructor's goal is to achieve the objectives of the curriculum by selecting activities which suit the student's needs and help him to master all the information and skills in the course. The most effective learning occurs when the student is a participant in the learning process, not a spectator.

An instructor should use learning activities which approximate the situations which the student will meet *in the treatment plant.* If it is not possible to teach in a treatment plant, *simulated situations* should be set up in the workshop or classroom so that the student can solve rather than discuss problems. *Group discussion* stimulated by *visual materials* is an effective learning technique. Lecturing, however, is inefficient. Because the student is not actively involved during a lecture, the instructor should use lectures sparingly.

Introduction to Modules of Instruction

In this instructor's guide the topics and ideas are presented as a series of modules, organized around the general objectives stated in the course descriptions for Plant Operation I, II, III and IV and the In-Plant Practicum which are found in the *Program Implementation Procedures* of the *CEWT Program*. Each module is designed to help the instructor plan a course of study for the operation of a treatment process using the CMP process unit. Each module is organized around sixteen objectives common to all processes.

The modules in *Plant Operations for Wastewater Facilities* are arranged in the order in which the CMP process units occur in the treatment plant. Each process is identified by a letter of the alphabet and the process unit is described in the heading of the module. If the instructor uses the modules in consecutive order, he and his students will follow the treatment of the wastestream from collection to its discharge into the receiving waters. Each module is designed so it can be used as a minicourse in a treatment process. Instructors are urged to group the modules to suit their individual curriculum needs and instructional situations.

Material in the modules can easily be adapted for courses which upgrade the training of operators in normal operation procedures, abnormal operation procedures, preventive maintenance procedures or corrective maintenance procedures by grouping the appropriate objectives from all the modules. For example, an instructor could develop a course in corrective maintenance by grouping objectives 11 and 12 from each module.

INSTRUCTIONAL PROCESS UNITS

Each module assumes that the composite model plant unit will be used for instruction in the process. If the recommended unit is not available, an alternate process unit may be substituted and the instructional materials adapted. The recommended CMP units and alternate units for all the processes are listed in table 1, page 4. Two modules on sludge dewatering are included because it is impossible for a student to master operation of this process by learning to operate one process unit. Remember, however, that a student will be more adequately prepared to work in almost any treatment plant if he is trained on the CMP unit. When it is not possible to use the recommended unit, students should be informed about the operation and function of the unit and hands-on training should be conducted on the best alternate unit available.

PURPOSE OF THE MODULES

The modules in *Plant Operations for Wastewater Facilities* help the student to learn how to operate all the process units in the wastewater treatment plant. Normal operation, abnormal operation, preventive maintenance and corrective maintenance procedures are included. When the course is completed, he will know why each unit is

TABLE I

SPECIFIC PROCESS UNITS RECOMMENDED FOR USE IN IMPLEMENTATION OF THE TWO-YEAR POST HIGH SCHOOL WASTEWATER TECHNOLOGY INSTRUCTIONAL PROGRAM

Module	Process	CMP Unit	Recommended Teaching Unit	Alternate Teaching Unit
1	Collection	A	Combined system with industrial waste	Sanitary system with industrial waste
2	Chlorination	B	Vacuum chlorinator with automatic feed to pipe, pneumatic control and electric evaporator	Vacuum chlorinator with automatic feed to pipe, electrical control and electric evaporator
		N	Vacuum chlorinator with automatic feed to pipe and closed-loop pneumatic control	Vacuum chlorinator with automatic feed to pipe and closed electrical control
3	Screening and Grinding	C	Mechanically cleaned bubbler control unit with grinder	Mechanically cleaned electrode control unit with grinder
4	Grit Removal	D	Aerated unit with bucket elevator	Aerated unit with screw conveyor
5	Primary Sedimentation	E	Rectangular unit with telescopic valve drawoff, density meter time clock and trough with scraper	Circular unit with telescopic valve drawoff, density meter time clock and trough with scraper
6	Trickling Filtration	F	Rotary distributor, standard rate unit with dosing tank	Rotary distributor, high rate unit
7	Aeration	G	Diffused air unit with swing-type diffuser producing fine bubbles	Mechanical aeration unit with turbine and sparger
8	Secondary Sedimentation	H	Circular, peripheral-feed unit with suction	Circular, center-feed unit with suction
9	Pond Stabilization	I	Aerobic pond	Facultative pond
10	Thickening	J	Floatation unit with air	Floatation unit with vacuum
11	First Stage Digestion	K	Fixed cover, gas recirculation unit with external heat exchanger	Floating cover, gas recirculation unit with external heat exchanger

12	Second Stage Digestion	L	Floating cover unit with gas storage	Fixed cover unit
13	Sludge Conditioning	M	Chemical conditioning unit with counter-current elutriation	None
14a	Sludge Dewatering	O	Vacuum filter unit with cloth	Vacuum filter unit with coil
14b	Sludge Dewatering	O	Continuous feed centrifuge	None
15	Solids Disposal	P	Multiple hearth incinerator unit	Fluidized bed incinerator unit
16	Effluent Disposal	Q	Direct reuse system	Underground disposal system
17	Flow Measurement	R	Centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter	None
18	Pumping and Piping	S	System with magnetically connected, pneumatically controlled, diesel driven, centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping	None
19	Electric Power	T	System using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms.	System using Y transformers, generators, electrical switchgear, automatic circuit actuators on motors and telemetering with alarms
20	Gas Power	U	System with internally produced gas with high pressure tanks and rotary positive displacement compressors	System with internally produced gas with high pressure tanks and reciprocating compressors

important to the treatment plant and how it affects and interacts with other process units in the treatment system.

STUDENT PREREQUISITES

Completion of Introduction to Environmental Technology and courses in basic mathematics and biology qualify the student to enter the course in Unit Operations for Wastewater Facilities. Concurrent courses in basic chemistry and laboratory control are suggested. (See pages 7 to 19 of *Program Implementation Procedures.*)

TERMINAL OBJECTIVE

When the student has completed the modules of instruction in this course, he should be able to do the following for each of the processes in the treatment plant:

1. Identify the process unit.
2. Describe the process unit in technical and nontechnical terms.
3. Describe the safety procedures for the process unit and explain how the procedures protect employees and visitors.
4. Identify the components of the process unit. Explain the purpose of each component, how the component works and why it is important.
5. Describe the normal operation procedures for the process unit components.
6. Perform the normal operation procedures for the process unit.
7. Describe and perform the start-up and shut-down procedures for the process unit.
8. Describe the abnormal operation procedures for the process unit.
9. Describe the preventive maintenance procedures for the process unit.
10. Perform the preventive maintenance procedures for the process unit.
11. Describe the corrective maintenance procedures for the process unit components.
12. Perform the corrective maintenance procedures for the process unit components.
13. Perform the safety procedures for the process unit and demonstrate how they protect employees and visitors.
14. Compare other process units to the composite model plant unit.
15. Name and locate the components of the process unit. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.
16. Perform the abnormal operation procedures for the process unit.

RESOURCES

The listing of instructional resources suggests materials now available to instructors to accomplish the desired performance in the student.

Instructional materials 1 to 1866 are keyed to the reference, *Instructional Materials Available* which is available from:

Office of Water Program Operations
US Environmental Protection Agency
Washington, DC 20460

Two companion volumes to *Instructional Materials Available*, also available from EPA, offer suggestions for selecting audio-visual equipment:

Selecting Audio-Visual Equipment
Selecting Instructional Media and Instructional Systems

The following journals list addresses of companies from whom literature about the process units which they manufacture can be obtained:

"Environmental Science and Technology"
1155 Sixteenth Street, N.W.
Washington, DC 20036

"Water and Sewage Works"
434 South Wabash
Chicago, IL 60605

"Water and Wastes Engineering"
666 Fifth Avenue
New York, NY 10019

If suitable materials are not available, instructors are urged to develop their own resources.

FORMAT OF THE MODULES

The module begins with a statement of purpose which explains what the student will be studying. Next, all the objectives of the module and code numbers keyed to a computerized list of instructional resources are listed for the instructor's convenience.

Objectives. Each module includes sixteen objectives which bring the student to the performance level required by the terminal objective. The knowledge and skills demanded of the student become more complex as he progresses through the sixteen objectives in a module. He begins by identifying components and learning facts about the components and processes. He uses these facts to develop concepts and ideas. Finally, he relates the concepts and ideas to each other so that he can make decisions about plant procedures.

A glossary of verbs which follows this introduction defines the verbs used in the objectives so that the instructor is aware of what he is instructing the student to do and so that his evaluation of the student is based solely on what is stated in the objective.

Conditions. The conditions define the circumstances under which the student performs and is evaluated and lists the information, equipment and assistance to which the student will have access. The best available learning and testing conditions should be used. A process unit in a treatment plant or workshop has more impact on the students than photographs and drawings. For example, if the student is to be given a process unit, unit components, photographs or diagrams of a unit, the instructor should provide a process unit. If a process unit is not available, he would use components of the unit in combination with photographs of those components which he does not have available. Line drawings and diagrams should not be used if photographs and manufacturers' illustrations are available.

Acceptable Performance. The acceptable performance expands the objective and details the steps a student must follow to reach the objective. To move on to the next objective, at least 70% of each step or category must be mastered with no repeated errors between modules. For example, no student can complete the course of study if he consistently fails to give attention to moving parts as he

performs safety procedures or to describe the odor as he evaluates the characteristics of the wastestream. In this section the instructor will find the main topics of his lesson plan and for the evaluation of the student's performance.

Instructor Activity. The instructor should get to know his class by working with small groups and with each student. He should encourage students to learn from each other as they work together. He should involve the student in the instructional and learning process. Instructional activities are paired numerically with student activities.

Student Activity. This is a listing of activities which the student will take part in, in order to accomplish the specified performance.

EVALUATION TECHNIQUE

The instructor may use or adapt the learning activities listed under instructor activity and student activity as evaluation techniques. The technique chosen should reflect what the objective asks the student to do. For example, if a student is asked to *describe*, the evaluation technique is a *description*. The student should be evaluated under the conditions and to the performance level required for each objective.

Glossary of Verbs

The glossary of verbs is included here so that the instructor will know exactly what the student is being asked to do to meet his objective. Notice the difference, for example, between the meanings of *identify* and *name*. When a student is asked to identify, the instructor is providing the name of the thing to be identified. But, when the student must name something, he must supply the name.

The list includes all the verbs from the objectives and the acceptable performance sections of all the modules, as well as some verbs used in the instructor and student activities.

	DEFINITION	APPLICATION
APPLY	To make use of as suitable, fitting or relevant.	Apply the preventive maintenance schedule for the second stage digestion unit.
CHECK	To inspect and ascertain the condition of, especially in order to determine that the condition is satisfactory.	Check the characteristics of each component.
COMMENT ON	To express an opinion or attitude about what has been seen or heard.	Comment on employee safety procedures.
COMPARE	To examine the character or qualities of, especially for the purpose of discovering resemblances or differences.	Compare other aeration units to the diffused air unit with swing-type diffuser producing fine bubbles.
CONSIDER	To give thought to with a view to purchasing, accepting or adopting.	Consider availability of replacement parts, capital costs, ease of repair, efficiency, maintenance costs, and so forth.
CORRECT	To alter or adjust to bring to some standard or required condition.	Correct the malfunction.
DEMONSTRATE	To illustrate or explain in an orderly and detailed way with many examples, specimens and particulars.	Demonstrate the start-up procedures in a treatment plant.

	DEFINITION	APPLICATION
DESCRIBE	To represent by words written or spoken for the knowledge or understanding of others, to transmit an image of the identifying features, the nature and characteristics of objects, events and actions.	Describe the safety procedures for the screening and grinding unit.
DEVELOP	To produce or generate.	Develop a picture file of first stage digestion units.
DISCUSS	To talk about, to present in detail, to exchange views or information about.	Discuss treatment plant case histories.
EVALUATE	To examine and make a judgement about quality, significance, amount, degree or condition of.	Evaluate the wastestream for abnormal conditions.
EXPLAIN	To make plain or clear, to present in detail.	Explain the purpose of each component, how the component works and why it is important.
IDENTIFY	To establish the identity of, pick out or single out an object in response to its name by pointing, picking up, underlining, marking or other responses.	Identify the components of the chlorination unit.
INDICATE	To state or express without going into detail.	Indicate whether the process unit is used for secondary sedimentation.
INSPECT	To view closely and critically, to determine quality or state, to detect errors or otherwise appraise.	Inspect a treatment plant.
LIST	To enumerate or specify.	List routine calculations for the pond stabilization unit.
LOCATE	To stipulate the position of an object in relation to other objects.	Locate the components of the trickling filtration unit.

	DEFINITION	APPLICATION
NAME	To supply the correct name, in oral or written form, for an object, class of objects, persons, places, conditions or events which are pointed out or described.	Name the components of the primary sedimentation unit.
OBSERVE	To pay careful, directed, analytical attention to.	Observe the thickening process during a plant tour.
PERFORM	To carry out an action or pattern of behavior. (Implies an act for which a process or pattern of movement has already been established, especially one calling for skill or precision, or for the assignment or assumption of responsibility.)	Perform the normal operation procedures for the grit removal unit.
POINT OUT	To indicate the position or direction of, especially by extending a finger toward the thing so indicated, to direct someone's attention to.	Point out characteristics which distinguish the first stage digestion unit from other units.
RECOMMEND	To mention or introduce as being worthy of acceptance, use or trial, to advise.	Recommend procedures to correct the unsafe conditions.
SELECT	To choose something from a number or group usually by fitness, excellence, or other distinguishing feature.	Select the reference materials and tools needed to perform the corrective maintenance.

MODULE 17

FLOW MEASUREMENT

A centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter

Composite Model Plant Unit R

PURPOSE: *In this module the student will learn to perform all the activities in the objectives as they apply to a centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

OBJECTIVES:

17.1 *Identify the flow measurement unit.*

17.2 *Describe the flow measurement process in technical and non-technical terms.*

17.3 *Describe the safety procedures for the flow measurement unit and explain how the procedures protect employees and visitors.*

17.4 *Identify the components of a flow measurement unit. Explain the purpose of each component, how the component works and why it is important.*

17.5 *Describe the normal operation procedures for the flow measurement unit components listed on page 17.*

17.6 *Perform the normal operation procedures for the flow measurement unit.*

17.7 *Describe and perform the start-up and shut-down procedures for the flow measurement unit.*

17.8 *The abnormal operation procedures do not apply to composite model plant unit R.*

17.9 *Describe the preventive maintenance procedures for the flow measurement unit.*

17.10 *Perform the preventive maintenance procedures for the flow measurement unit.*

17.11 *Describe the corrective maintenance procedures for the flow measurement unit components listed on page 17.*

17.12 *Perform the corrective maintenance procedures for the flow measurement unit components.*

17.13 *Perform the safety procedures for the flow measurement unit and demonstrate how they protect employees and visitors.*

17.14 *Compare other flow measurement units to the centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter.*

17.15 *Name and locate the components of the flow measurement unit*

listed on page 17. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

17.16 The abnormal operation procedures do not apply to composite model plant unit R.

RESOURCES: 3 116 120 125 141 143 144 215 216 217 218 307 308 309 316 317 320 321 324 421 459 511 551 552 553 554 937 990 1033 1034 1399

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OBJECTIVE 17.1: *Identify the flow measurement unit.*

CONDITIONS: Given a unit, a model of a unit or a photograph of a unit.

ACCEPTABLE PERFORMANCE: The student will:

Indicate whether the process unit is used for flow measurement.

INSTRUCTOR ACTIVITY:

1. Point out characteristics which distinguish the flow measurement unit from other process units.

STUDENT ACTIVITY:

1. Develop a picture file of flow measurement units. Mark distinguishing characteristics.

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OBJECTIVE 17.2: *Describe the flow measurement process in technical and nontechnical terms.*

CONDITIONS: Given photographs of the flow measurement unit.

ACCEPTABLE PERFORMANCE: The student will:

Describe the flow measurement unit, explaining the meaning of the metering system.

Describe the purpose of flow measurement.

Describe how flow measurement affects:
- collection
- prechlorination
- screening and grinding
- grit removal
- primary sedimentation
- trickling filtration
- aeration
- secondary sedimentation
- pond stabilization
- thickening
- first stage digestion
- second stage digestion
- sludge conditioning
- post-chlorination
- sludge dewatering
- solids disposal
- effluent disposal
- pumping and piping

INSTRUCTOR ACTIVITY:

1. Use diagrams, photographs and slides to describe flow measurement.
2. Describe the flow measurement process during a plant tour. React to the student's description of the process.

STUDENT ACTIVITY:

1. Describe the flow measurement process while viewing photographs, diagrams and slides.
2. Observe and describe the flow measurement process during a plant tour.

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OBJECTIVE 17.3: *Describe the safety procedures for the flow measurement unit and explain how the procedures protect employees and visitors.*

CONDITIONS: Given a list of operation and maintenance procedures.

ACCEPTABLE PERFORMANCE: The student will:

Describe the safety procedures for the flow measurement unit, commenting on:
- High-risk activities
  - removing debris from channels

working with switches in automatic position
Sources of danger
acid wastes
caustic wastes
deep wells
electrical equipment
explosive gases
moving parts
open doors and covers
pits
poorly ventilated or open pits
slippery walks
toxic gases
Safety equipment
first-aid kit
lockout tags and keys
protective clothing
railings
stair safety treads

Explain how the procedures protect employees and visitors.

INSTRUCTOR ACTIVITY:

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation and maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.

STUDENT ACTIVITY:

1. Read case histories and comment on employee safety procedures.
2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the flow measurement unit.
4. Identify sources of danger and high-risk activities pictured in slides.

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OBJECTIVE 17.4: *Identify the components of a flow measurement unit. Explain the purpose of each component, how the component works and why it is important.*

CONDITIONS: Given a flow measurement unit, unit components or a diagram, model or photographs of a unit and a list of components.

ACCEPTABLE PERFORMANCE: The student will:

Identify components of the flow measurement unit and associated equipment:

- chart
- electrical-hydraulic transmission system
- fire-fighting equipment
- first-aid kit
- magnetic flowmeter
  - flow indicator
  - flow recorder
  - transmitter
- mechanical-hydraulic transmission system
- Parshall flume
  - float
  - float switch
  - flow indicator
  - stilling well
  - transmitter
- pen
- pneumatic transmission system
- rotameter
- signal converter
- totalizer
- Venturi meter
  - flow indicator
  - flushing pump
  - plunger
  - sight glass

Explain the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out and name components in diagrams, photographs or models.
2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.
4. Question the students about the purpose of each component, how the component works and why it is important.

STUDENT ACTIVITY:

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.
3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

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OBJECTIVE 17.5: *Describe the normal operation procedures for the flow measurement unit components listed on page 17.*

CONDITIONS: Given a flow measurement unit or slides or photographs of a flow measurement unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

ACCEPTABLE PERFORMANCE: The student will:

Describe the characteristics of each component which the operator checks to determine whether the component is functioning normally, commenting on:

agitation	position
color	pressure
corrosion	sound
depth	temperature
flow	velocity
motion	vibration

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why the component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:

- making adjustments
- deciding about corrective maintenance
- reporting to supervisors
- reporting in written records

Explain why a component's characteristics must be returned to normal.

Describe routine sampling for the flow measurement process.

List routine calculations for the flow measurement process.

Describe routine procedures for recording data.

INSTRUCTOR ACTIVITY:

1. Describe the characteristics of the components of the flow measurement unit.
2. Describe the normal operation procedures for the flow measurement unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the flow measurement unit.
4. Describe and explain the normal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Develop a checklist, listing the components of the flow measurement unit and their normal characteristics.
2. Develop a manual of normal operation procedures.
3. Describe the normal operation procedures during a slide show of components of the flow measurement unit.
4. Observe and describe the normal operation procedures during a plant tour.

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OBJECTIVE 17.6: *Perform the normal operation procedures for the flow measurement unit.*

CONDITIONS: Given a flow measurement unit, the manual of normal operation procedures which the student has developed for the flow measurement unit and basic references.

ACCEPTABLE PERFORMANCE: The student will:

Check and evaluate the characteristics of each component, explaining his actions.

Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.

Perform the routine sampling.

Perform the routine calculations.

Perform the routine record keeping.

INSTRUCTOR ACTIVITY:

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

STUDENT ACTIVITY:

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.
2. Perform and explain the normal operation procedures in a treatment plant.

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OBJECTIVE 17.7: *Describe and perform the start-up and shut-down procedures for the flow measurement unit.*

CONDITIONS: Given a mock-up, model or photograph of a flow measurement unit and a flow measurement unit with the manufacturer's operation manual.

ACCEPTABLE PERFORMANCE: The student will:

Start up and shut down a flow measurement unit, following the manufacturer's instructions.

INSTRUCTOR ACTIVITY:

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.
6. Observe the student as he evaluates his shut-down procedures.

STUDENT ACTIVITY:

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.
4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the flow measurement unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the flow measurement unit to determine whether correct shut-down procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)

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OBJECTIVE 17.8: *The abnormal operation procedures do not apply to composite model plant unit R.*

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OBJECTIVE 17.9: *Describe the preventive maintenance procedures for the flow measurement unit.*

CONDITIONS: Given a flow measurement unit or pictures and drawings of a flow measurement unit and reference materials, including:

inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Describe these preventive maintenance procedures for the flow measurement unit:

Cleaning
magnetic flowmeter
flow indicator
flow recorder
transmitter

Cleaning (continued)
- Parshall flume
  - float
  - float switch
  - flow indicator
  - stilling well
  - transmitter
- pen
- Venturi meter
  - flow indicator
  - flushing pump
  - plunger
  - sight glass

Lubrication
- Venturi meter
  - flushing pump

Mechanical adjustment
- electrical-hydraulic transmission system
- magnetic flowmeter
  - flow indicator
  - flow recorder
  - transmitter
- mechanical-hydraulic transmission system
- Parshall flume
  - float
  - float switch
  - flow indicator
  - transmitter
- pneumatic transmission system
- signal converter
- totalizer
- Venturi meter
  - flushing pump

Painting
- Venturi meter
  - flushing pump

Replacement
- chart
- fire-fighting equipment
- first-aid kit
- magnetic flowmeter
  - flow indicator
  - flow recorder
  - transmitter
- Parshall flume
  - transmitter
- pen
- rotameter

Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.

Explain how an operator determines whether a component needs preventive maintenance.

Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

INSTRUCTOR ACTIVITY:

1. Describe and explain the preventive maintenance procedures for the flow measurement unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

STUDENT ACTIVITY:

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.
3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

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OBJECTIVE 17.10: *Perform the preventive maintenance procedures for the flow measurement unit.*

CONDITIONS: Given a flow measurement unit and tools and reference materials, including:

inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.

Apply the preventive maintenance schedule for the flow measurement unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

<<<<<<>>>>>>

OBJECTIVE 17.11: *Describe the corrective maintenance procedures for the flow measurement unit components listed on page 17.*

CONDITIONS: Given a flow measurement unit or a mock-up, photographs or drawings of a flow measurement unit, the manual of operation procedures which the student has developed for the flow measurement unit, tools and reference materials, including:

catalogue of replacement parts
equipment catalogues
manufacturer's maintenance guides

ACCEPTABLE PERFORMANCE: The student will:

Describe how an operator evaluates each component of the flow measurement unit for corrective maintenance, commenting on:

agitation	position
color	pressure
corrosion	sound
depth	temperature
flow	velocity
motion	vibration

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.

Describe what an operator does when he discovers a malfunction, including:
- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Describe how the operator corrects the malfunction.

INSTRUCTOR ACTIVITY:

1. Describe and explain the corrective maintenance procedures for the flow measurement unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

STUDENT ACTIVITY:

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

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OBJECTIVE 17.12: *Perform the corrective maintenance procedures for the flow measurement unit components.*

CONDITIONS: Given a flow measurement unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:
- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides
- manufacturer's operation manual

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the components of the flow measurement unit for corrective maintenance, explaining why a component has malfunctioned and commenting on:

agitation	position
color	pressure
corrosion	sound
depth	temperature
flow	velocity
motion	vibration

Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:
- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.
3. Observe the student performing the corrective maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

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OBJECTIVE 17.13: *Perform the safety procedures for the flow measurement unit and demonstrate how they protect employees and visitors.*

CONDITIONS: Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.

ACCEPTABLE PERFORMANCE: The student will:

Identify hazardous conditions in the flow measurement unit, commenting on:
- high-risk activities
- sources of danger
- safety equipment

Explain how the procedures protect employees and visitors.

Recommend corrective procedures and correct the unsafe condition.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate safety conditions in simulated situations and recommend corrective procedures.
2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.
3. Perform the safety procedures in a treatment plant.

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OBJECTIVE 17.14: *Compare other flow measurement units to the centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter.*

CONDITIONS: Given a process unit and reference materials, including:
- equipment catalogues
- laboratory reports
- manufacturer's bulletins
- manufacturer's operation manuals
- plant maintenance and operation records

ACCEPTABLE PERFORMANCE: The student will:

Compare composite model plant unit R with:
- a V-notch weir unit.
- a rectangular weir unit.
- a proportional flow weir unit.
- a Kennison nozzle unit.

Consider:
availability of replacement parts
capital costs
dependency on surrounding environment
ease of repair
efficiency
flow-handling capabilities
maintenance costs
nuisance to neighbors
operational costs
operational skills
personnel requirements
reliability
resistance to upset
sensitivity of controls
space requirements
waste-handling capabilities

INSTRUCTOR ACTIVITY:

1. Prepare a chart for tabulation of information about the units.
2. Compare composite model plant unit R with the other units.
3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

STUDENT ACTIVITY:

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

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OBJECTIVE 17.15:

Name and locate the components of the flow measurement unit listed on page 17. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

CONDITIONS:

Given a flow measurement unit, unit components or a diagram, model or photographs of a unit and reference materials, including:
contractor's plans of the flow measurement unit
manufacturer's maintenance guides
operation and maintenance manuals

ACCEPTABLE PERFORMANCE: The student will:

Name and locate the components of the flow measurement unit.

Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out components of the flow measurement unit on diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the flow measurement unit and normal operation procedures.

STUDENT ACTIVITY:

1. Name the components which the instructor points out on diagrams, photographs or models.
2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.
3. Name and select the reference materials which describe the flow measurement unit and normal operation procedures.

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OBJECTIVE 17.16: *The abnormal operation procedures do not apply to composite model plant unit R.*

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MODULE 18

PUMPING AND PIPING

A system with magnetically connected, pneumatically controlled, diesel driven, centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping

Composite Model Plant Unit S

PURPOSE: *In this module the student will learn to perform all the activities in the objectives as they apply to a system with magnetically connected, pneumatically controlled, diesel driven, centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

OBJECTIVES:

18.1 *Identify the pumping and piping unit.*

18.2 *Describe the pumping and piping process in technical and non-technical terms.*

18.3 *Describe the safety procedures for the pumping and piping unit and explain how the procedures protect employees and visitors.*

18.4 *Identify the components of a pumping and piping unit. Explain the purpose of each component, how the component works and why it is important.*

18.5 *Describe the normal operation procedures for the pumping and piping unit components listed on page 36.*

18.6 *Perform the normal operation procedures for the pumping and piping unit.*

18.7 *Describe and perform the start-up and shut-down procedures for the pumping and piping unit.*

18.8 *Describe the abnormal operation procedures for the pumping and piping process.*

18.9 *Describe the preventive maintenance procedures for the pumping and piping unit.*

18.10 *Perform the preventive maintenance procedures for the pumping and piping unit.*

18.11 *Describe the corrective maintenance procedures for the pumping and piping unit components listed on page 36.*

18.12 *Perform the corrective maintenance procedures for the pumping and piping unit components.*

18.13 *Perform the safety procedures for the pumping and piping unit and demonstrate how they protect employees and visitors.*

18.14 *Compare other pumping and piping units to the system with magnetically connected, pneumatically controlled, diesel driven,*

centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.

18.15 Name and locate the components of the pumping and piping unit listed on page 36.
explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

18.16 Perform the abnormal operation procedures for the pumping and piping unit.

RESOURCES: 3 116 120 125 141 143 144 196 197 209 271 272 307 308 309 316 317 320 321 324 421 459 511 551 552 553 554 937 990 1033 1034 1399

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OBJECTIVE 18.1: *Identify the pumping and piping unit.*

CONDITIONS: Given a unit, a model of a unit or a photograph of a unit.

ACCEPTABLE PERFORMANCE: The student will:

Indicate whether the process unit is used for pumping and piping.

INSTRUCTOR ACTIVITY:

1. Point out characteristics which distinguish the pumping and piping unit from other process units.

STUDENT ACTIVITY:

1. Develop a picture file of pumping and piping units. Mark distinguishing characteristics.

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OBJECTIVE 18.2: *Describe the pumping and piping process in technical and nontechnical terms.*

CONDITIONS: Given photographs of the pumping and piping unit.

ACCEPTABLE PERFORMANCE: The student will:

Describe the pumping and piping unit, explaining the meaning of:
- hydraulic system
- piping system
- pumping and piping system
- pumping system

Describe the purpose of pumping and piping.

Describe the pumps in the pumping and piping unit which are used for:
- backwash
- priming
- process water
- raw sewage
- recirculation
- recycle
- settled sewage
- sludge
- sludge return
- waste sludge
- water seals

Describe the valves in the pumping and piping unit, commenting on the:
- butterfly valve
- bypass valve
- check valve
- discharge valve
- effluent valve
- gate valve
- influent valve
- inlet valve
- suction valve

Describe the pipes in the pumping and piping unit, commenting on the:
- bypass line
- discharge line
- effluent line
- line
- influent line
- overflow line
- primary sludge line
- recirculation line
- recycle line
- sludge line
- suction line
- transfer line

Describe how pumping and piping affects:
- aeration
- collection
- effluent disposal
- first stage digestion
- flow measurement
- grit removal
- pond stabilization
- post-chlorination
- preclorination
- primary sedimentation
- screening and grinding
- secondary sedimentation
- second stage digestion
- sludge conditioning
- sludge dewatering
- solids disposal
- thickening
- trickling

INSTRUCTOR ACTIVITY:

1. Use diagrams, photographs and slides to describe pumping and piping.

2. Describe the pumping and piping process during a plant tour. React to the student's description of the process.

STUDENT ACTIVITY:

1. Describe the pumping and piping process while viewing photographs, diagrams and slides.
2. Observe and describe the pumping and piping process during a plant tour.

<<<<<<>>>>>>

OBJECTIVE 18.3: *Describe the safety procedures for the pumping and piping unit and explain how the procedures protect employees and visitors.*

CONDITIONS: Given a list of operation and maintenance procedures.

ACCEPTABLE PERFORMANCE: The student will:

Describe the safety procedures for the pumping and piping unit, commenting on:

- High-risk activities
  - handling contaminated equipment
  - removing debris from channels
  - working with switches in automatic position
- Scurces of danger
  - air tanks and lines
  - acid wastes
  - caustic wastes
  - deep wells
  - electrical equipment
  - explosive gases
  - flooding tunnels
  - heat
  - hoist equipment under tension
  - hot manifolds
  - hot pipes
  - loose clothing
  - moving parts
  - open doors and covers
  - rotating and reciprocating parts
  - slippery walks
  - toxic gases

Safety equipment
- earmuffs and earplugs
- explosion proof flashlights
- fire-fighting equipment
- first-aid kit
- goggles
- grounded tools and extension cords
- lockout tags and keys
- protective clothing
- safety solvents

Explain how the procedures protect employees and visitors.

INSTRUCTOR ACTIVITY:

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation and maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.

STUDENT ACTIVITY:

1. Read case histories and comment on employee safety procedures.
2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the pumping and piping unit.
4. Identify sources of danger and high-risk activities pictured in slides.

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OBJECTIVE 18.4:

Identify the components of a pumping and piping unit. Explain the purpose of each component, how the component works and why it is important.

CONDITIONS:

Given a pumping and piping unit, unit components or a diagram, model or photographs of a unit and a list of components.

ACCEPTABLE PERFORMANCE: The student will:

Identify components of the pumping and piping unit and associated equipment:

belt	pipe
control system	pump
coupling	seal
fire-fighting equipment	speed controller
first-aid kit	switch
gage	valve
motor	

Explain the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out and name components in diagrams, photographs or models.
2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.
4. Question the students about the purpose of each component, how the component works and why it is important.

STUDENT ACTIVITY:

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.
3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

<<<<<<>>>>>>

OBJECTIVE 18.5: *Describe the normal operation procedures for the pumping and piping unit components listed above.*

CONDITIONS: Given a pumping and piping unit or slides or photographs of a pumping and piping unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

ACCEPTABLE PERFORMANCE: The student will:

Describe the characteristics of each component which the operator checks to determine whether the

component is functioning normally, commenting on:

capacity	odor
color	position
corrosion	pressure
exfiltration	sound
flow	temperature
infiltration	vibration
motion	

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why the component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:
- making adjustments
- deciding about corrective maintenance
- reporting to supervisors
- reporting in written records

Explain why a component's characteristics must be returned to normal.

Describe routine sampling for the pumping and piping process.

List routine calculations for the pumping and piping process.

Describe routine procedures for recording data.

INSTRUCTOR ACTIVITY:

1. Describe the characteristics of the components of the pumping and piping unit.
2. Describe the normal operation procedures for the pumping and piping unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the pumping and piping unit.
4. Describe and explain the normal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Develop a checklist, listing the components of the pumping and piping unit and their normal characteristics.
2. Develop a manual of normal operation procedures.

3. Describe the normal operation procedures during a slide show of components of the pumping and piping unit.
4. Observe and describe the normal operation procedures during a plant tour.

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OBJECTIVE 18.6: *Perform the normal operation procedures for the pumping and piping unit.*

CONDITIONS: Given a pumping and piping unit, the manual of normal operation procedures which the student has developed for the pumping and piping unit and basic references.

ACCEPTABLE PERFORMANCE: The student will:

Check and evaluate the characteristics of each component, explaining his actions.

Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.

Perform the routine sampling.

Perform the routine calculations.

Perform the routine record keeping.

INSTRUCTOR ACTIVITY:

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

STUDENT ACTIVITY:

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.
2. Perform and explain the normal operation procedures in a treatment plant.

<<<<<<>>>>>>

OBJECTIVE 18.7: *Describe and perform the start-up and shut-down procedures for the pumping and piping unit.*

CONDITIONS: Given mock-ups, models or photographs of the components of a pumping and piping unit and the components of a pumping and piping unit with the manufacturer's operation manual.

ACCEPTABLE PERFORMANCE: The student will:

Start up and shut down a pumping and piping unit, following the manufacturer's instructions.

INSTRUCTOR ACTIVITY:

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.
6. Observe the student as he evaluates his shut-down procedures.

STUDENT ACTIVITY:

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.
4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the pumping and piping unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the pumping and piping unit to determine whether correct shut-down procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)

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OBJECTIVE 18.8: *Describe the abnormal operation procedures for the pumping and piping process.*

CONDITIONS:

Given a wastestream in a treatment plant or color photographs of a wastestream, a checklist of the conditions of the wastestream and plant records and reference materials.

ACCEPTABLE PERFORMANCE:

The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

flow	pH
ice	sludge density
industrial wastes	velocity

Describe the cause and effect of the abnormal condition.

Explain how often the condition of the wastestream must be checked.

Describe what an operator does if he observes abnormal conditions, including:
- operational changes
- reporting to supervisors
- sampling procedures

Describe how the actions of the operator will improve the condition of the wastestream.

INSTRUCTOR ACTIVITY:

1. Describe and explain the abnormal conditions of the wastestream illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.
3. Describe and explain the abnormal operation procedures during a slide show.
4. Describe and explain the abnormal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Evaluate and explain the abnormal conditions of the wastestream which are illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.
3. Describe and explain the abnormal operation procedures in a class discussion after a slide show.

4. Evaluate and explain the condition of the wastestream during a plant tour. Describe and explain the abnormal operation procedures.

<<<<<<>>>>>>

OBJECTIVE 18.9: *Describe the preventive maintenance procedures for the pumping and piping unit.*

CONDITIONS: Given a pumping and piping unit or pictures and drawings of a pumping and piping unit and reference materials, including:

inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Describe these preventive maintenance procedures for the pumping and piping unit:

- Cleaning
  - gage
  - motor
  - pipe
  - pump
  - speed controller
  - valve
- Lubrication
  - motor
  - pump
  - seal
  - speed controller
  - valve
- Mechanical adjustment
  - belt
  - control system
  - coupling
  - gage
  - motor
  - pump
  - seal
  - speed controller
  - switch
  - valve
- Painting
  - motor
  - pipe
  - pump
  - speed controller
  - valve
- Replacement
  - belt
  - fire-fighting equipment
  - first-aid kit
  - seal
- Wear measurement
  - belt coupling
  - seal

Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.

Explain how an operator determines whether a component needs preventive maintenance.

Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

INSTRUCTOR ACTIVITY:

1. Describe and explain the preventive maintenance procedures for the pumping and piping unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

STUDENT ACTIVITY:

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.
3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

<<<<<<>>>>>>

OBJECTIVE 18.10: *Perform the preventive maintenance procedures for the pumping and piping unit.*

CONDITIONS: Given a pumping and piping unit and tools and reference materials, including:

inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.

Apply the preventive maintenance schedule for the pumping and piping unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

<<<<<<>>>>>>

OBJECTIVE 18.11:

Describe the corrective maintenance procedures for the pumping and piping unit components listed on page 36.

CONDITIONS:

Given a pumping and piping unit or a mock-up, photographs or drawings of a pumping and piping unit, the manual of operation procedures which the student has developed for the pumping and piping unit, tools and reference materials, including:

catalogue of replacement parts
equipment catalogues
manufacturer's maintenance guides

ACCEPTABLE PERFORMANCE:

The student will:

Describe how an operator evaluates each component of the pumping and piping unit for corrective maintenance, commenting on:

capacity	odor
color	position
corrosion	pressure
exfiltration	sound
flow	temperature
infiltration	vibration
motion	

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.

Describe what an operator does when he discovers a malfunction, including:
- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Describe how the operator corrects the malfunction.

INSTRUCTOR ACTIVITY:

1. Describe and explain the corrective maintenance procedures for the pumping and piping unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

STUDENT ACTIVITY:

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

<<<<<<>>>>>>

OBJECTIVE 18.12: *Perform the corrective maintenance procedures for the pumping and piping unit components.*

CONDITIONS: Given a pumping and piping unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:
- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides
- manufacturer's operation manual

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the components of the pumping and piping unit for corrective maintenance, explaining why a component has malfunctioned and commenting on:
- capacity
- color
- corrosion
- exfiltration

flow	pressure
infiltration	sound
motion	temperature
odor	vibration
position	

Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:
- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.
3. Observe the student performing the corrective maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

<<<<<<>>>>>>

OBJECTIVE 18.13: *Perform the safety procedures for the pumping and piping unit and demonstrate how they protect employees and visitors.*

CONDITIONS: Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.

ACCEPTABLE PERFORMANCE: The student will:

Identify hazardous conditions in the pumping and piping unit, commenting on:
- high-risk activities

sources of danger
safety equipment

Explain how the procedures protect employees and visitors.

Recommend corrective procedures and correct the unsafe condition.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate safety conditions in simulated situations and recommend corrective procedures.
2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.
3. Perform the safety procedures in a treatment plant.

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OBJECTIVE 18.14:

Compare other pumping and piping units to the system with magnetically connected, pneumatically controlled, diesel driven, centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.

CONDITIONS:

Given a process unit and reference materials, including:
equipment catalogues
laboratory reports
manufacturer's bulletins
manufacturer's operation manuals
plant maintenance and operation records

ACCEPTABLE PERFORMANCE:

The student will:

Compare composite model plant unit S with:
a system with magnetically connected, pneumatically controlled, diesel driven, air lift pump; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.
a system with magnetically connected, pneumatically

controlled, diesel driven, screw lift pump; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.

a system with magnetically connected, pneumatically controlled, diesel driven, hand driven pump; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.

a system with magnetically connected, pneumatically controlled, diesel driven, water driven pump; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.

a system with magnetically connected, pneumatically controlled, diesel driven, air driven pump; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and the appropriate piping.

a system with magnetically connected, pneumatically controlled, diesel driven, pneumatic ejector pump electrode controlled; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping.

Consider:

availability of replacement parts
capital costs
dependency on surrounding environment
ease of repair
efficiency
flow-handling capabilities
maintenance costs
nuisance to neighbors
operational costs
operational skills
personnel requirements
reliability
resistance to upset
sensitivity of controls
space requirements
waste-handling capabilities

INSTRUCTOR ACTIVITY:

1. Prepare a chart for tabulation of information about the units.
2. Compare composite model plant unit S with the other units.

3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

STUDENT ACTIVITY:

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

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OBJECTIVE 18.15:

Name and locate the components of the pumping and piping unit listed on page 36. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

CONDITIONS:

Given a pumping and piping unit, unit components or a diagram, model or photographs of a unit and reference materials, including:

contractor's plans of the pumping and piping unit.
manufacturer's maintenance guides
operation and maintenance manuals

ACCEPTABLE PERFORMANCE:

The student will:

Name and locate the components of the pumping and piping unit.

Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out components of the pumping and piping unit on diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the pumping and piping unit and normal operation procedures.

STUDENT ACTIVITY:

1. Name the components which the instructor points out on diagrams, photographs or models.

2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.
3. Name and select the reference materials which describe the pumping and piping unit and normal operation procedures.

<<<<<<>>>>>>

OBJECTIVE 18.16: *Perform the abnormal operation procedures for the pumping and piping unit.*

CONDITIONS: Given a wastestream in a treatment plant and reference materials, including:
- industrial waste records
- operation logs
- operator manuals
- plant performance guides

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

flow	pH
ice	sludge density
industrial wastes	velocity

Select the references he needs to return the wastestream to normal.

Perform the abnormal operation procedures.

INSTRUCTOR ACTIVITY:
1. Observe the student as he evaluates the wastestream in a treatment plant.
2. Describe the references needed to correct abnormal conditions of the wastestream.
3. Observe the student performing the abnormal operation procedures in simulated situations and in a treatment plant.

STUDENT ACTIVITY:
1. Evaluate the wastestream in a treatment plant.
2. Select the references needed to correct abnormal conditions of the wastestream.
3. Perform the abnormal operation procedures in simulated situations or in a treatment plant.

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MODULE 19

ELECTRIC POWER

A system using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms

Composite Model Plant Unit T

PURPOSE: *In this module the student will learn to perform all the activities in the objectives as they apply to a system using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

OBJECTIVES:

19.1 *Identify the electric power unit.*

19.2 *Describe the electric power process in technical and nontechnical terms.*

19.3 *Describe the safety procedures for the electric power unit and explain how the procedures protect employees and visitors.*

19.4 *Identify the components of an electric power unit. Explain the purpose of each component, how the component works and why it is important.*

19.5 *Describe the normal operation procedures for the electric power unit components listed on page 55.*

19.6 *Perform the normal operation procedures for the electric power unit.*

19.7 *Describe and perform the start-up and shut-down procedures for the electric power unit.*

19.8 *The abnormal operation procedures do not apply to the composite model plant unit T.*

19.9 *Describe the preventive maintenance procedures for the electric power unit.*

19.10 *Perform the preventive maintenance procedures for the electric power unit.*

19.11 *Describe the corrective maintenance procedures for the electric power unit components listed on page 55.*

19.12 *Perform the corrective maintenance procedures for the electric power unit components.*

19.13 *Perform the safety procedures for the electric power unit and demonstrate how they protect employees and visitors.*

19.14 *Compare other electric power units to the system using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms.*

19.15 Name and locate the components of the electric power unit listed on page 55.
explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

19.16 The abnormal operation procedures do not apply to the composite model plant unit T.

RESOURCES: 3 116 120 125 141 143 144 212 213 307 308
309 312 313 316 317 320 321 324 421 459 511
551 552 553 554 937 990 1033 1034 1399

<<<<<<>>>>>>

OBJECTIVE 19.1: *Identify the electric power unit.*

CONDITIONS: Given a unit, a model of a unit or a photograph of a unit.

ACCEPTABLE PERFORMANCE: The student will:

Indicate whether the process unit is used for electric power.

INSTRUCTOR ACTIVITY:

1. Point out characteristics which distinguish the electric power unit from other process units.

STUDENT ACTIVITY:

1. Develop a picture file of electric power units. Mark distinguishing characteristics.

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OBJECTIVE 19.2: *Describe the electric power process in technical and nontechnical terms.*

CONDITIONS: Given photographs of the electric power unit.

ACCEPTABLE PERFORMANCE: The student will:

Describe the electric power unit, explaining the meaning of:
delta

electrical distribution system
electrical generation and distribution system
electrical service
electrical supply
internal electrical system
plant electrical system
three-phase

Describe the purpose of the electric power unit.

Describe how electric power affects:
collection
prechlorination
screening and grinding
grit removal
primary sedimentation
trickling filtration
aeration
secondary sedimentation
pond stabilization
thickening
first stage digestion
second stage digestion
sludge conditioning
post-chlorination
sludge dewatering
solids disposal
effluent disposal
flow measurement
pumping and piping

INSTRUCTOR ACTIVITY:

1. Use diagrams, photographs and slides to describe electric power.
2. Describe the electric power process during a plant tour. React to the student's description of the process.

STUDENT ACTIVITY:

1. Describe the electric power process while viewing photographs, diagrams and slides.
2. Observe and describe the electric power process during a plant tour.

<<<<<<>>>>>>

OBJECTIVE 19.3: *Describe the safety procedures for the electric power unit and explain how the procedures protect employees and visitors.*

CONDITIONS: Given a list of operation and maintenance procedures.

ACCEPTABLE PERFORMANCE: The student will:

Describe the safety procedures for the electric power unit, commenting on:

- High-risk activities
  - activating or deactivating circuits
  - working with switches in automatic position
- Sources of danger
  - electrical equipment
  - explosive atmosphere
  - explosive gases
  - flammable solvents
  - hot equipment
  - moving parts
  - noise
  - open doors and covers
  - rotating equipment
  - slippery walks
  - solvents
  - toxic gases
- Safety equipment
  - earmuffs or earplugs
  - explosion proof flashlight
  - fire-fighting equipment
  - first-aid kit
  - load break ratings on switchgear
  - lockout tags and keys
  - padlocks
  - protective clothing
  - railings
  - rubber mats under all switchgear panels
  - shorting sticks
  - wooden ladders

Explain how the procedures protect employees and visitors.

INSTRUCTOR ACTIVITY:

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation and maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.

STUDENT ACTIVITY:

1. Read case histories and comment on employee safety procedures.
2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the electric power unit.
4. Identify sources of danger and high-risk activities pictured in slides.

<<<<<<>>>>>>

OBJECTIVE 19.4:

Identify the components of an electric power unit. Explain the purpose of each component, how the component works and why it is important.

CONDITIONS:

Given an electric power unit, unit components or a diagram, model or photographs of a unit and a list of components.

ACCEPTABLE PERFORMANCE:

The student will:

Identify components of the electric power unit and associated equipment:

- ammeter
- automatic control actuator
- diesel motor
- disconnect switch
- elapsed-time meter
- emergency lighting system
- exciter
- feeder breaker
- fire-fighting equipment
- first-aid kit
- frequency meter
- generator
- ground detector
- lighting transformer
- load bus
- load distribution panel
- magnetic starter
- motor control center
- overvoltage relay
- power-factor meter
- power-generation control
- primary feeder breaker
- transformer breaker
- undervoltage relay
- voltmeter
- watt-hour meter

Explain the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out and name components in diagrams, photographs or models.

2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.
4. Question the students about the purpose of each component, how the component works and why it is important.

STUDENT ACTIVITY:

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.
3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

<<<<<<>>>>>>

OBJECTIVE 19.5: *Describe the normal operation procedures for the electric power unit components listed on page 55.*

CONDITIONS: Given an electric power unit or slides or photographs of an electric power unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

ACCEPTABLE PERFORMANCE: The student will:

Describe the characteristics of each component which the operator checks to determine whether the component is functioning normally, commenting on:

color	position
corrosion	sound
motion	temperature
odor	vibration

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why a component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:

making adjustments

deciding about corrective maintenance
reporting to supervisors
reporting in written records

Explain why a component's characteristics must be returned to normal.

Describe routine sampling for the electric power process.

List routine calculations for the electric power process.

Describe routine procedures for recording data.

INSTRUCTOR ACTIVITY:

1. Describe the characteristics of the components of the electric power unit.
2. Describe the normal operation procedures for the electric power unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the electric power unit.
4. Describe and explain the normal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Develop a checklist, listing the components of the electric power unit and their normal characteristics.
2. Develop a manual of normal operation procedures.
3. Describe the normal operation procedures during a slide show of components of the electric power unit.
4. Observe and describe the normal operation procedures during a plant tour.

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OBJECTIVE 19.6: *Perform the normal operation procedures for the electric power unit.*

CONDITIONS: Given an electric power unit, the manual of normal operation procedures which the student has developed for the electric power unit and basic references.

ACCEPTABLE PERFORMANCE: The student will:

Check and evaluate the characteristics of each component, explaining his actions.

Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.

Perform the routine sampling.

Perform the routine calculations.

Perform the routine record keeping.

INSTRUCTOR ACTIVITY:

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

STUDENT ACTIVITY:

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.
2. Perform and explain the normal operation procedures in a treatment plant.

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OBJECTIVE 19.7: *Describe and perform the start-up and shut-down procedures for the electric power unit.*

CONDITIONS: Given a mock-up, model or photograph of an electric power unit and an electric power unit with the manufacturer's operation manual.

ACCEPTABLE PERFORMANCE: The student will:

Start up and shut down an electric power unit, following the manufacturer's instructions.

INSTRUCTOR ACTIVITY:

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.

6. Observe the student as he evaluates his shut-down procedures.

STUDENT ACTIVITY:

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.
4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the electric power unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the electric power unit to determine whether correct shut-down procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)

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OBJECTIVE 19.8: *The abnormal operation procedures do not apply to the composite model plant unit T.*

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OBJECTIVE 19.9: *Describe the preventive maintenance procedures for the electric power unit.*

CONDITIONS: Given an electric power unit or pictures and drawings of an electric power unit and reference materials, including:

inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Describe these preventive maintenance procedures for the electric power unit:

- Cleaning
  - ammeter
  - automatic control actuator
  - diesel motor
  - disconnect switch
  - elapsed-time meter
  - emergency lighting system
  - exciter
  - feeder breaker
  - frequency meter
  - generator
  - lighting transformer
  - load bus
  - load distribution panel
  - magnetic starter
  - motor control center
  - overvoltage relay
  - power-factor meter
  - power-generation control
  - primary feeder breaker
  - transformer breaker
  - undervoltage relay
  - voltmeter
  - watt-hour meter
- Lubrication
  - diesel motor
  - exciter
  - generator
- Mechanical adjustment
  - ammeter
  - automatic control actuator
  - diesel motor
  - disconnect switch
  - elapsed-time meter
  - emergency lighting system
  - exciter
  - feeder breaker
  - frequency meter
  - generator
  - ground detector
  - lighting transformer
  - load bus
  - load distribution panel
  - magnetic starter
  - motor control center
  - overvoltage relay
  - power-factor meter
  - power-generation control
  - primary feeder breaker
  - transformer breaker
  - undervoltage relay
  - voltmeter
  - watt-hour meter
- Painting
  - diesel motor
  - exciter
  - generator
  - motor control center
- Replacement
  - fire-fighting equipment
  - first-aid kit
- Wear measurement
  - diesel motor
  - exciter
  - generator
  - magnetic starter
  - overvoltage relay
  - primary feeder breaker
  - undervoltage relay

Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.

Explain how an operator determines whether a component needs preventive maintenance.

Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

INSTRUCTOR ACTIVITY:

1. Describe and explain the preventive maintenance procedures for the electric power unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

STUDENT ACTIVITY:

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.
3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

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OBJECTIVE 19.10: *Perform the preventive maintenance procedures for the electric power unit.*

CONDITIONS: Given an electric power unit and tools and reference materials, including:
inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.

Apply the preventive maintenance schedule for the electric power unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

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OBJECTIVE 19.11: *Describe the corrective maintenance procedures for the electric power unit components listed on page 55.*

CONDITIONS:

Given an electric power unit or a mock-up, photographs or drawings of an electric power unit, the manual of operation procedures which the student has developed for the electric power unit, tools and reference materials, including:

- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides

ACCEPTABLE PERFORMANCE:

The student will:

Describe how an operator evaluates each component of the electric power unit for corrective maintenance, commenting on:

color	position
corrosion	sound
motion	temperature
odor	vibration

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.

Describe what an operator does when he discovers a malfunction, including:

- evaluation of capabilities of plant personnel to perform the procedures

selection of replacement parts
record keeping

Describe how the operator corrects the malfunction.

INSTRUCTOR ACTIVITY:

1. Describe and explain the corrective maintenance procedures for the electric power unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

STUDENT ACTIVITY:

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

<<<<<<>>>>>>

OBJECTIVE 19.12: *Perform the corrective maintenance procedures for the electric power unit components.*

CONDITIONS: Given an electric power unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:

catalogue of replacement parts
equipment catalogues
manufacturer's maintenance guides
manufacturer's operation manual

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the components of the electric power unit for corrective maintenance, explaining why a component has malfunctioned and commenting on:

color	position
corrosion	sound
motion	temperature
odor	vibration

Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:
- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.
3. Observe the student performing the corrective maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

<<<<<<>>>>>>

OBJECTIVE 19.13: *Perform the safety procedures for the electric power unit and demonstrate how they protect employees and visitors.*

CONDITIONS: Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.

ACCEPTABLE PERFORMANCE: The student will:

Identify hazardous conditions in the electric power unit, commenting on:
- high-risk activities
- sources of danger
- safety equipment

Explain how the procedures protect employees and visitors.

Recommend corrective procedures and correct the unsafe condition.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate safety conditions in simulated situations and recommend corrective procedures.
2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.
3. Perform the safety procedures in a treatment plant.

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OBJECTIVE 19.14: *Compare other electric power units to the system using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms.*

CONDITIONS: Given a process unit and reference materials, including:

equipment catalogues
laboratory reports
manufacturer's bulletins
manufacturer's operation manuals
plant maintenance and operation records

ACCEPTABLE PERFORMANCE: The student will:

Compare composite model plant unit T with:
- a system using Y transformers, generators, electrical switchgear, automatic circuit actuators on motors and telemetering with alarms.
- a system with internally produced gas with gas holder covers and centrifugal blowers.

Consider:
- availability of replacement parts
- capital costs
- dependency on surrounding environment
- ease of repair
- efficiency

flow-handling capabilities
maintenance costs
nuisance to neighbors
operational costs
operational skills
personnel requirements
reliability
resistance to upset
sensitivity of controls
space requirements
waste-handling capabilities

INSTRUCTOR ACTIVITY:

1. Prepare a chart for tabulation of information about the units.
2. Compare composite model plant unit T with the other units.
3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

STUDENT ACTIVITY:

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

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OBJECTIVE 19.15:

Name and locate the components of the electric power unit listed on page 55. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

CONDITIONS:

Given an electric power unit, unit components or a diagram, model or photographs of a unit and reference materials, including:

contractor's plans of the electric power unit
manufacturer's maintenance guides
operation and maintenance manuals

ACCEPTABLE PERFORMANCE:

The student will:

Name and locate the components of the electric power unit.

Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out components of the electric power unit on diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the electric power unit and normal operation procedures.

STUDENT ACTIVITY:

1. Name the components which the instructor points out on diagrams, photographs or models.
2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.
3. Name and select the reference materials which describe the electric power unit and normal operation procedures.

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OBJECTIVE 19.16: *The abnormal operation procedures do not apply to the composite model plant unit T.*

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MODULE 20

GAS POWER

A system with internally produced gas with high pressure tanks and rotary positive displacement compressors

Composite Model Plant Unit U

PURPOSE: *In this module the student will learn to perform all the activities in the objectives as they apply to a system with internally produced gas with high pressure tanks and rotary positive displacement compressors. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

OBJECTIVES:

20.1 *Identify the gas power unit.*

20.2 *Describe the gas power process in technical and nontechnical terms.*

20.3 *Describe the safety procedures for the gas power unit and explain how the procedures protect employees and visitors.*

20.4 *Identify the components of a gas power unit. Explain the purpose of each component, how the component works and why it is important.*

20.5 *Describe the normal operation procedures for the gas power unit components listed on page 73.*

20.6 *Perform the normal operation procedures for the gas power unit.*

20.7 *Describe and perform the start-up and shut-down procedures for the gas power unit.*

20.8 *Describe the abnormal operation procedures for the gas power process.*

20.9 *Describe the preventive maintenance procedures for the gas power unit.*

20.10 *Perform the preventive maintenance procedures for the gas power unit.*

20.11 *Describe the corrective maintenance procedures for the gas power unit components listed on page 73.*

20.12 *Perform the corrective maintenance procedures for the gas power unit components.*

20.13 *Perform the safety procedures for the gas power unit and demonstrate how they protect employees and visitors.*

20.14 *Compare other gas power units to the system with internally produced gas with high pressure tanks and rotary positive displacement compressors (composite model plant unit U).*

20.15 *Name and locate the components of the gas power unit listed on page 73. Name and select reference materials which explain*

the normal operation procedures, the purpose of each component, how the component works and why it is important.

20.16 Perform the abnormal operation procedures for the gas power unit.

RESOURCES: 3 116 120 125 141 143 144 307 308 309 316 317 320 321 324 421 459 511 551 552 553 554 937 990 1033 1034 1399

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OBJECTIVE 20.1: *Identify the gas power unit.*

CONDITIONS: Given a unit, a model of a unit or a photograph of a unit.

ACCEPTABLE PERFORMANCE: The student will:

Indicate whether the process unit is used for gas power.

INSTRUCTOR ACTIVITY:

1. Point out characteristics which distinguish the gas power unit from other process units.

STUDENT ACTIVITY:

1. Develop a picture file of gas power units. Mark distinguishing characteristics.

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OBJECTIVE 20.2: *Describe the gas power process in technical and nontechnical terms.*

CONDITIONS: Given photographs of the gas power unit.

ACCEPTABLE PERFORMANCE: The student will:

Describe the gas power unit, explaining the meaning of:

digester gas system
high pressure gas system

low pressure gas system
plant gas system
process gas system
sludge gas system
waste gas system

Describe the purpose of the gas power unit.

Describe how gas power affects:
first stage digestion
second stage digestion
pumping and piping

INSTRUCTOR ACTIVITY:

1. Use diagrams, photographs and slides to describe gas power.
2. Describe the gas power process during a plant tour. React to the student's description of the process.

STUDENT ACTIVITY:

1. Describe the gas power process while viewing photographs, diagrams and slides.
2. Observe and describe the gas power process during a plant tour.

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OBJECTIVE 20.3: *Describe the safety procedures for the gas power unit and explain how the procedures protect employees and visitors.*

CONDITIONS: Given a list of operation and maintenance procedures.

ACCEPTABLE PERFORMANCE: The student will:

Describe the safety procedures for the gas power unit, commenting on:
High-risk activities
draining water from lines
hoisting
removing debris from channels
working with switches in automatic position
Sources of danger
acid wastes
belts
caustic wastes
cleaning rags

Sources of danger (continued)
- couplings
- deep wells
- disconnected pipelines
- electrical equipment
- explosive gases
- explosive mixtures
- gas leaks
- H_2S gas
- high pressure
- improper disposal of spent gas scrubber contents
- iron sulfide
- moving parts
- negative pressure
- open doors and covers
- rotating equipment
- slippery walks
- solvents
- spent gas scrubber contents
- toxic gases
- valve chains
- valve handles
- welding torches

Safety equipment
- continuous operation gas monitor
- explosion meter
- explosion proof equipment
- fire-fighting equipment
- first-aid kit
- high volume ventilation equipment
- hydrogen sulfide amp tools
- lockout tags and keys
- nonsparking tools
- protective clothing
- railings
- salt tablets
- stair safety treads

Explain how the procedures protect employees and visitors.

INSTRUCTOR ACTIVITY:

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation and maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.

STUDENT ACTIVITY:

1. Read case histories and comment on employee safety procedures.
2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the gas power unit.
4. Identify sources of danger and high-risk activities pictured in slides.

<<<<<<>>>>>>

OBJECTIVE 20.4:

Identify the components of a gas power unit. Explain the purpose of each component, how the component works and why it is important.

CONDITIONS:

Given a gas power unit, unit components or a diagram, model or photographs of a unit and a list of components.

ACCEPTABLE PERFORMANCE:

The student will:

Identify components of the gas power unit and associated equipment:

drip trap	manometer
explosion-proof switchgear	meter
fire-fighting equipment	moisture accumulator
first-aid kit	pressure gage
flame arrestor	pressure switch
gas booster	primary gas receiver
gas compressor	secondary gas receiver
gas filter	vacuum relief valve
gas holder cover	valve
gas scrubber	waste gas burner
gas storage	

Explain the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out and name components in diagrams, photographs or models.
2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.

4. Question the students about the purpose of each component, how the component works and why it is important.

STUDENT ACTIVITY:

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.
3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

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OBJECTIVE 20.5: *Describe the normal operation procedures for the gas power unit components listed on page 73.*

CONDITIONS: Given a gas power unit or slides or photographs of a gas power unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

ACCEPTABLE PERFORMANCE: The student will:

Describe the characteristics of each component which the operator checks to determine whether the component is functioning normally, commenting on:

color	pressure
corrosion	sound
motion	temperature
odor	vibration
position	

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why the component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:

making adjustments
deciding about corrective maintenance

reporting to supervisors
reporting in written records

Explain why a component's characteristics must be returned to normal.

Describe routine sampling for the gas power process.

List routine calculations for the gas power process.

Describe routine procedures for recording data.

INSTRUCTOR ACTIVITY:

1. Describe the characteristics of the components of the gas power unit.
2. Describe the normal operation procedures for the gas power unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the gas power unit.
4. Describe and explain the normal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Develop a checklist, listing the components of the gas power unit and their normal characteristics.
2. Develop a manual of normal operation procedures.
3. Describe the normal operation procedures during a slide show of components of the gas power unit.
4. Observe and describe the normal operation procedures during a plant tour.

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OBJECTIVE 20.6: *Perform the normal operation procedures for the gas power unit.*

CONDITIONS: Given a gas power unit, the manual of normal operation procedures which the student has developed for the gas power unit and basic references.

ACCEPTABLE PERFORMANCE: The student will:

Check and evaluate the characteristics of each component, explaining his actions.

Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.

Perform the routine sampling.

Perform the routine calculations.

Perform the routine record keeping.

INSTRUCTOR ACTIVITY:

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

STUDENT ACTIVITY:

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.
2. Perform and explain the normal operation procedures in a treatment plant.

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OBJECTIVE 20.7: *Describe and perform the start-up and shut-down procedures for the gas power unit.*

CONDITIONS: Given a mock-up, model or photograph of a gas power unit and a gas power unit with the manufacturer's operation manual.

ACCEPTABLE PERFORMANCE: The student will:

Start up and shut down a gas power unit, following the manufacturer's instructions.

INSTRUCTOR ACTIVITY:

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.
6. Observe the student as he evaluates his shut-down procedures.

STUDENT ACTIVITY:

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.
4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the gas power unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the gas power unit to determine whether correct shut-down procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)

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OBJECTIVE 20.8: *Describe the abnormal operation procedures for the gas power process.*

CONDITION:

Given a gas stream in a treatment plant or a written description of a gas stream, a checklist of the conditions of the gas stream and plant records and reference materials.

ACCEPTABLE PERFORMANCE:

The student will:

Evaluate the gas stream for abnormal conditions, commenting on:
- flow
- gas composition
- toxic gases

Describe the cause and effect of the abnormal condition.

Explain how often the condition of the gas stream must be checked.

Describe what an operator does if he observes abnormal conditions, including:
- operational changes
- reporting to supervisors
- sampling procedures

Describe how the actions of the operator will improve the condition of the gas stream.

INSTRUCTOR ACTIVITY:

1. Describe and explain the abnormal conditions of the gas stream.
2. Describe and explain the abnormal operation procedures described in plant records and case histories.
3. Describe and explain the abnormal operation procedures during a slide show.
4. Describe and explain the abnormal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Evaluate and explain the abnormal conditions of the gas stream which the instructor describes.
2. Describe and explain the abnormal operation procedures described in plant records and case histories.
3. Describe and explain the abnormal operation procedures in a class discussion after a slide show.
4. Evaluate and explain the condition of the gas stream during a plant tour. Describe and explain the abnormal operation procedures.

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OBJECTIVE 20.9: *Describe the preventive maintenance procedures for the gas power unit.*

CONDITIONS: Given a gas power unit or pictures and drawings of a gas power unit and reference materials, including:

inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Describe these preventive maintenance procedures for the gas power unit:

Cleaning
- drip trap
- flame arrestor
- gas booster
- gas compressor
- gas filter
- gas scrubber
- gas storage
- meter
- moisture accumulator

- Cleaning (continued)
  - pressure gage
  - pressure switch
  - valve
  - waste gas burner
- Lubrication
  - gas booster
  - gas compressor
  - gas scrubber
  - meter
  - valve
- Mechanical adjustment
  - drip trap
  - explosion-proof switchgear
  - flame arrestor
  - gas booster
  - gas compressor
  - gas scrubber
  - meter
  - moisture accumulator
  - pressure gage
  - pressure switch
  - vacuum relief valve
  - valve
  - waste gas burner
- Painting
  - flame arrestor
  - gas compressor
  - gas scrubber
  - gas storage
  - meter
  - moisture accumulator
  - primary gas receiver
  - secondary gas receiver
  - valve
- Replacement
  - fire-fighting equipment
  - first-aid kit
  - gas filter
  - gas scrubber
  - manometer

Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.

Explain how an operator determines whether a component needs preventive maintenance.

Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

INSTRUCTOR ACTIVITY:

1. Describe and explain the preventive maintenance procedures for the gas power unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

STUDENT ACTIVITY:

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.

3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

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OBJECTIVE 20.10: *Perform the preventive maintenance procedures for the gas power unit.*

CONDITIONS: Given a gas power unit and tools and reference materials, including:
inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.

Apply the preventive maintenance schedule for the gas power unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.

INSTRUCTOR ACTIVITY:
1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

STUDENT ACTIVITY:
1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

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OBJECTIVE 20.11: *Describe the corrective maintenance procedures for the gas power unit components listed on page 73.*

CONDITIONS:

Given a gas power unit or a mock-up, photographs or drawings of a gas power unit, the manual of operation procedures which the student has developed for the gas power unit, tools and reference materials, including:
- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides

ACCEPTABLE PERFORMANCE:

The student will:

Describe how an operator evaluates each component of the gas power unit for corrective maintenance, commenting on:
- color
- corrosion
- motion
- odor
- position
- pressure
- sound
- temperature
- vibration

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.

Describe what an operator does when he discovers a malfunction, including:
- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Describe how the operator corrects the malfunction.

INSTRUCTOR ACTIVITY:

1. Describe and explain the corrective maintenance procedures for the gas power unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

STUDENT ACTIVITY:

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.

3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

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OBJECTIVE 20.12: *Perform the corrective maintenance procedures for the gas power unit components.*

CONDITIONS: Given a gas power unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:
- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides
- manufacturer's operation manual

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the components of the gas power unit for corrective maintenance, explaining why a component has malfunctioned and commenting on:
- color
- corrosion
- motion
- odor
- position
- pressure
- sound
- temperature
- vibration

Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:
- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

INSTRUCTOR ACTIVITY:
1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.
3. Observe the student performing the corrective maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

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OBJECTIVE 20.13: *Perform the safety procedures for the gas power unit and demonstrate how they protect employees and visitors.*

CONDITIONS: Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.

ACCEPTABLE PERFORMANCE: The student will:

Identify hazardous conditions in the gas power unit, commenting on:
- high-risk activities
- sources of danger
- safety equipment

Explain how the procedures protect employees and visitors.

Recommend corrective procedures and correct the unsafe condition.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate safety conditions in simulated situations and recommend corrective procedures.
2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.
3. Perform the safety procedures in a treatment plant.

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OBJECTIVE 20.14: *Compare other gas power units to the system with internally produced gas with high pressure tanks and rotary positive displacement compressors (composite model plant unit U).*

CONDITIONS: Given a process unit and reference materials, including:
- equipment catalogues
- laboratory reports
- manufacturer's bulletins
- manufacturer's operation manuals
- plant maintenance and operation records

ACCEPTABLE PERFORMANCE: The student will:

Compare composite model plant unit U with:
- a system with internally produced gas with high pressure tanks and reciprocating compressors.
- a system with internally produced gas with gas holder covers and centrifugal blowers.

Consider:
- availability of replacement parts
- capital costs
- dependency on surrounding environment
- ease of repair
- efficiency
- flow-handling capabilities
- gas-handling capabilities
- maintenance costs
- nuisance to neighbors
- operational costs
- operational skills
- personnel requirements
- reliability
- resistance to upset
- sensitivity of controls
- space requirements

INSTRUCTOR ACTIVITY:
1. Prepare a chart for tabulation of information about the units.
2. Compare composite model plant unit U with the other units.
3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

STUDENT ACTIVITY:

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

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OBJECTIVE 20.15:

Name and locate the components of the gas power unit listed on page 73. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

CONDITIONS:

Given a gas power unit, unit components or a diagram, model or photographs of a unit and reference materials, including:

contractor's plans of the gas power unit
manufacturer's maintenance guides
operation and maintenance manuals

ACCEPTABLE PERFORMANCE:

The student will:

Name and locate the components of the gas power unit.

Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out components of the gas power unit or diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the gas power unit and normal operation procedures.

STUDENT ACTIVITY:

1. Name the components which the instructor points out on diagrams, photographs or models.
2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.

3. Name and select the reference materials which describe the gas power unit and normal operation procedures.

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OBJECTIVE 20.16: *Perform the abnormal operation procedures for the gas power unit.*

CONDITIONS: Given a gas stream in a treatment plant and reference materials, including:
- industrial waste records
- operation logs
- operator manuals
- plant performance guides

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the gas stream for abnormal conditions, commenting on:
- flow
- gas composition
- toxic gases

Select the references he needs to return the gas stream to normal.

Perform the abnormal operation procedures.

INSTRUCTOR ACTIVITY:
1. Observe the student as he evaluates the gas stream in a treatment plant.
2. Describe the references needed to correct abnormal conditions of the gas stream.
3. Observe the student performing the abnormal operation procedures in simulated situations and in a treatment plant.

STUDENT ACTIVITY:
1. Evaluate the gas stream in a treatment plant.
2. Select the references needed to correct abnormal conditions of the gas stream.
3. Perform the abnormal operation procedures in simulated situations or in a treatment plant.

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